



# Precision, Low-Voltage Analog Switches

## General Description

The MAX381/MAX383/MAX385 are precision, low-voltage analog switches. The single-pole single-throw MAX381 and double-pole single-throw MAX385 dual switches are normally open. The single-pole double-throw MAX383 has two normally open and two normally closed poles. All three parts offer low on-resistance (less than  $35\Omega$ ), guaranteed to match to within  $2\Omega$  between channels and to remain flat over the specified analog signal range ( $4\Omega$  max). They also offer low leakage (less than  $250\text{pA}$  at  $+25^\circ\text{C}$  and less than  $2.5\text{nA}$  at  $+85^\circ\text{C}$ ) and fast switching (turn-on time less than  $175\text{ns}$  and turn-off time less than  $100\text{ns}$ ).

The MAX381/MAX383/MAX385 are fabricated with Maxim's low-voltage silicon-gate process for high system accuracy. Design improvements guarantee extremely low charge injection ( $<5\text{pC}$ ) and low power consumption ( $<10\mu\text{W}$ ).

These monolithic switches operate with a single positive supply ( $+3\text{V}$  to  $+15\text{V}$ ) or with split supplies ( $\pm 3\text{V}$  to  $\pm 8\text{V}$ ) while retaining CMOS-logic input compatibility and fast switching. CMOS inputs provide reduced input loading.

## Applications

|                              |                          |
|------------------------------|--------------------------|
| Sample-and-Hold Circuits     | Military Radios          |
| Test Equipment               | Communication Systems    |
| Heads-Up Displays            | Battery-Operated Systems |
| Audio Signal Routing         | PBX, PABX                |
| Guidance and Control Systems |                          |

## Features

- ♦ Single-Supply Operation ( $+3\text{V}$  to  $+15\text{V}$ )  
Bipolar-Supply Operation ( $\pm 3\text{V}$  to  $\pm 8\text{V}$ )
- ♦ Pin-Compatible with DG401/DG403/DG405
- ♦ Low On-Resistance,  $20\Omega$  Typical ( $35\Omega$  Max)
- ♦ Guaranteed Matched On-Resistance Between Channels,  $<2\Omega$
- ♦ Guaranteed Flat On-Resistance over Specified Analog Signal Range,  $<4\Omega$
- ♦ Guaranteed Charge Injection,  $<5\text{pC}$
- ♦ Guaranteed Off-Channel Leakage,  $<2.5\text{nA}$  at  $+85^\circ\text{C}$
- ♦ TTL/CMOS-Logic Compatible with  $3\text{V}$ ,  $5\text{V}$ ,  $\pm 3\text{V}$ , and  $\pm 5\text{V}$  Supplies
- ♦ Rail-to-Rail Analog Signal Handling Capability

## Ordering Information

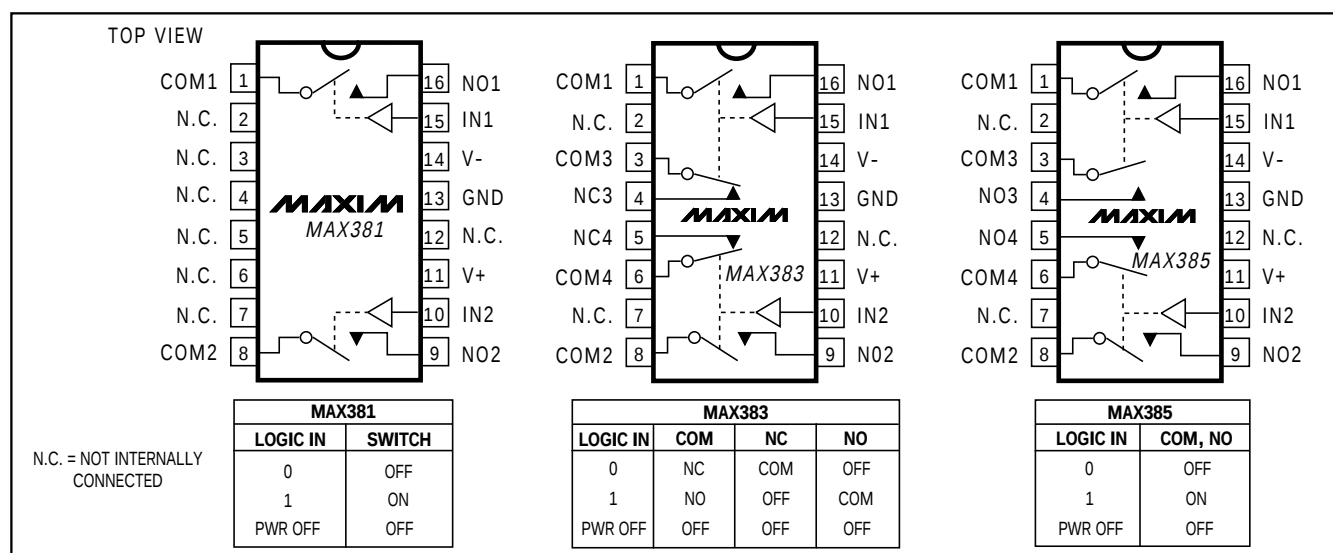
| PART      | TEMP. RANGE                                 | PIN-PACKAGE    |
|-----------|---------------------------------------------|----------------|
| MAX381CPE | $0^\circ\text{C}$ to $+70^\circ\text{C}$    | 16 Plastic DIP |
| MAX381CSE | $0^\circ\text{C}$ to $+70^\circ\text{C}$    | 16 Narrow SO   |
| MAX381C/D | $0^\circ\text{C}$ to $+70^\circ\text{C}$    | Dice*          |
| MAX381EPE | $-40^\circ\text{C}$ to $+85^\circ\text{C}$  | 16 Plastic DIP |
| MAX381ESE | $-40^\circ\text{C}$ to $+85^\circ\text{C}$  | 16 Narrow SO   |
| MAX381EJE | $-40^\circ\text{C}$ to $+85^\circ\text{C}$  | 16 CERDIP**    |
| MAX381MJE | $-55^\circ\text{C}$ to $+125^\circ\text{C}$ | 16 CERDIP**    |

Ordering Information continued on last page.

\* Dice are tested at  $T_A = +25^\circ\text{C}$  only.

\*\* Contact factory for package availability.

## Pin Configurations/Block Diagrams/Truth Tables



# Precision, Low-Voltage Analog Switches

## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to GND

V+ .....-0.3V to +17V

V- .....+0.3V to -17V

V+ to V- .....-0.3V to +17V

COM\_, NO\_, NC\_, IN\_ .....(V- - 2V) to (V+ + 2V) or 30mA,  
whichever occurs first

Continuous Current, any pin .....30mA

Peak Current, any pin  
(pulsed at 1ms, 10% duty cycle max) .....100mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

Plastic DIP (derate 10.53mW/°C above +70°C) .....842mW

Narrow SO (derate 8.70mW/°C above +70°C) .....696mW

CERDIP (derate 10.00mW/°C above +70°C) .....800mW

Operating Temperature Ranges

MAX38\_C\_E .....0°C to +70°C

MAX38\_E\_E .....-40°C to +85°C

MAX38\_MJE .....-55°C to +125°C

Storage Temperature Range .....-65°C to +150°C

Lead Temperature (soldering, 10sec) .....+300°C

**Note 1:** Signals on NC, NO, COM, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

| PARAMETER                                     | SYMBOL                                                     | CONDITIONS                                                                                                                                                | TEMP. RANGE                                              | MIN     | TYP (Note 2) | MAX   | UNITS |
|-----------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------|--------------|-------|-------|
| <b>SWITCH</b>                                 |                                                            |                                                                                                                                                           |                                                          |         |              |       |       |
| Analog Signal Range                           | V <sub>COM</sub> ,<br>V <sub>NO</sub> ,<br>V <sub>NC</sub> | (Note 3)                                                                                                                                                  |                                                          | V-      |              | V+    | V     |
| On-Resistance                                 | R <sub>ON</sub>                                            | V+ = 4.5V, V- = -4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = ±3.5V,<br>I <sub>COM</sub> = -10mA,<br>V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0.8V | T <sub>A</sub> =<br>+25°C                                | C, E    | 20           | 35    | Ω     |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | 20           | 30    |       |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M |              | 45    |       |
| On-Resistance Match Between Channels (Note 4) | ΔR <sub>ON</sub>                                           | V <sub>NC</sub> or V <sub>NO</sub> = ±3V,<br>I <sub>COM</sub> = -10mA,<br>V+ = 5V, V- = -5V                                                               | T <sub>A</sub> =<br>+25°C                                | C, E, M | 0.5          | 2     | Ω     |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M |              | 4     |       |
| On-Resistance Flatness (Note 4)               | R <sub>FLAT(ON)</sub>                                      | V <sub>NC</sub> or V <sub>NO</sub> = 3V, 0V,<br>-3V; I <sub>COM</sub> = -10mA,<br>V+ = 5V, V- = -5V                                                       | T <sub>A</sub> =<br>+25°C                                | C, E, M |              | 4     | Ω     |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M |              | 6     |       |
| NC or NO Off Leakage Current (Note 5)         | I <sub>NC(OFF)</sub><br>or<br>I <sub>NO(OFF)</sub>         | V <sub>COM</sub> = ±4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = ∓4.5V,<br>V+ = 5.5V, V- = -5.5V                                                         | T <sub>A</sub> =<br>+25°C                                | C, E    | -0.2         | -0.01 | nA    |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -0.1         | -0.01 |       |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E    | -2.5         |       |       |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -5.0         |       |       |
| COM Off Leakage Current (Note 5)              | I <sub>COM(OFF)</sub>                                      | V <sub>COM</sub> = ±4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = ∓4.5V,<br>V+ = 5.5V, V- = -5.5V                                                         | T <sub>A</sub> =<br>+25°C                                | C, E    | -0.2         | -0.01 | nA    |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -0.1         | -0.01 |       |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E    | -2.5         |       |       |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -5.0         |       |       |
| COM On Leakage Current (Note 5)               | I <sub>COM(ON)</sub>                                       | V <sub>COM</sub> = ±4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V,<br>V+ = 5.5V, V- = -5.5V                                                         | T <sub>A</sub> =<br>+25°C                                | C, E    | -0.4         | -0.04 | nA    |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -0.2         | -0.04 |       |
|                                               |                                                            |                                                                                                                                                           | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E    | -5.0         |       |       |
|                                               |                                                            |                                                                                                                                                           |                                                          | M       | -20.0        |       |       |

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                             | SYMBOL                | CONDITIONS                                                                                                    |                                                       | MIN  | TYP<br>(Note 2) | MAX | UNITS |
|---------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|------|-----------------|-----|-------|
| DIGITAL LOGIC INPUT                   |                       |                                                                                                               |                                                       |      |                 |     |       |
| Input Current with Input Voltage High | I <sub>INH</sub>      | V <sub>IN</sub> = 2.4V, all others = 0.8V                                                                     |                                                       | -1.0 | 0.005           | 1.0 | μA    |
| Input Current with Input Voltage Low  | I <sub>INL</sub>      | V <sub>IN</sub> = 0.8V, all others = 2.4V                                                                     |                                                       | -1.0 | 0.005           | 1.0 | μA    |
| Logic High Input Voltage              | V <sub>AH</sub>       |                                                                                                               | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 2.4  |                 |     | V     |
| Logic Low Input Voltage               | V <sub>AL</sub>       |                                                                                                               | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> |      |                 | 0.8 | V     |
| DYNAMIC                               |                       |                                                                                                               |                                                       |      |                 |     |       |
| Turn-On Time                          | t <sub>ON</sub>       | V <sub>COM</sub> = 3V, Figure 2                                                                               | T <sub>A</sub> = +25°C                                | 100  |                 | 175 | ns    |
|                                       |                       |                                                                                                               | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 225  |                 |     |       |
| Turn-Off Time                         | t <sub>OFF</sub>      | V <sub>COM</sub> = 3V, Figure 2                                                                               | T <sub>A</sub> = +25°C                                | 60   |                 | 100 | ns    |
|                                       |                       |                                                                                                               | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> | 150  |                 |     |       |
| Break-Before-Make Time Delay (Note 3) | t <sub>D</sub>        | MAX383 only, Figure 3                                                                                         | T <sub>A</sub> = +25°C                                | 10   | 20              |     | ns    |
| Charge Injection (Note 3)             | V <sub>CTE</sub>      | C <sub>L</sub> = 1.0nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0Ω, Figure 4                                | T <sub>A</sub> = +25°C                                | 2    |                 | 5   | pC    |
| Off Isolation (Note 6)                | V <sub>ISO</sub>      | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 5                                               | T <sub>A</sub> = +25°C                                | 72   |                 |     | dB    |
| Crosstalk (Note 7)                    | V <sub>CT</sub>       | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, Figure 6                                                | T <sub>A</sub> = +25°C                                | 90   |                 |     | dB    |
| Off Capacitance                       | C <sub>OFF</sub>      | f = 1MHz, Figure 7                                                                                            | T <sub>A</sub> = +25°C                                | 12   |                 |     | pF    |
| COM Off Capacitance                   | C <sub>COM(OFF)</sub> | f = 1MHz, Figure 7                                                                                            | T <sub>A</sub> = +25°C                                | 12   |                 |     | pF    |
| Channel On Capacitance                | C <sub>COM(ON)</sub>  | f = 1MHz, Figure 8                                                                                            | T <sub>A</sub> = +25°C                                | 39   |                 |     | pF    |
| SUPPLY                                |                       |                                                                                                               |                                                       |      |                 |     |       |
| Power-Supply Range                    |                       |                                                                                                               |                                                       | ±3   |                 | ±8  | V     |
| Positive Supply Current               | I <sup>+</sup>        | All channels on or off, V <sup>+</sup> = 5.5V, V <sup>-</sup> = -5.5V, V <sub>IN</sub> = 0V or V <sup>+</sup> |                                                       | -1.0 | 0.06            | 1.0 | μA    |
| Negative Supply Current               | I <sup>-</sup>        | All channels on or off, V <sup>+</sup> = 5.5V, V <sup>-</sup> = -5.5V, V <sub>IN</sub> = 0V or V <sup>+</sup> |                                                       | -1.0 | -0.01           | 1.0 | μA    |

**Note 2:** The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

**Note 3:** Guaranteed by design.

**Note 4:**  $\Delta R_{ON} = \Delta R_{ON(max)} - \Delta R_{ON(min)}$ . On-resistance match between channels and flatness are guaranteed only with specified voltages. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

**Note 5:** Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at room temperature.

**Note 6:** See Figure 4. Off isolation =  $20\log_{10} V_{COM}/V_{NC}$  or  $V_{NO}$ . VCOM = output, VNC or NO = input to off switch.

**Note 7:** Between any two switches. See Figure 5.

**Note 8:** Leakage testing at single supply is guaranteed by testing with dual supplies.

# Precision, Low-Voltage Analog Switches

## ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +5V ±10%, V- = 0V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                                        | SYMBOL                                                     | CONDITIONS                                                                                                                                            |                                                          | TEMP. RANGE | MIN   | TYP (Note 2) | MAX  | UNITS |
|--------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------|-------|--------------|------|-------|
| SWITCH                                           |                                                            |                                                                                                                                                       |                                                          |             |       |              |      |       |
| Analog Signal Range                              | V <sub>COM</sub> ,<br>V <sub>NO</sub> ,<br>V <sub>NC</sub> | (Note 3)                                                                                                                                              |                                                          |             | 0V    |              | V+   | V     |
| On-Resistance                                    | R <sub>ON</sub>                                            | V+ = 5.0V, V- = 0V,<br>V <sub>NC</sub> or V <sub>NO</sub> = 3.5V,<br>I <sub>COM</sub> = 1.0mA,<br>V <sub>INH</sub> = 2.4V,<br>V <sub>INL</sub> = 0.8V | T <sub>A</sub> = +25°C                                   | C, E        | 25    | 65           | Ω    |       |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | 60    |              |      |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M     | 75    |              |      |       |
| On-Resistance Match<br>Between Channels (Note 4) | ΔR <sub>ON</sub>                                           | V <sub>NC</sub> or V <sub>NO</sub> = 3V,<br>I <sub>COM</sub> = 1.0mA,<br>V+ = 5V                                                                      | T <sub>A</sub> = +25°C                                   | C, E, M     | 0.5   | 2            | Ω    |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M     | 4     |              |      |       |
| On-Resistance Flatness<br>(Note 4)               | R <sub>FLAT(ON)</sub>                                      | V <sub>NC</sub> or V <sub>NO</sub> = 3V, 2V,<br>1V; I <sub>COM</sub> = 1.0mA;<br>V+ = 5V; V- = 0V                                                     | T <sub>A</sub> = +25°C                                   | C, E, M     |       | 6            | Ω    |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E, M     | 8     |              |      |       |
| NC or NO Off Leakage<br>Current (Note 8)         | I <sub>NC(OFF)</sub><br>or<br>I <sub>NO(OFF)</sub>         | V <sub>COM</sub> = 0V,<br>V <sub>NC</sub> or V <sub>NO</sub> = 4.5V,<br>V+ = 5.5V, V- = 0V                                                            | T <sub>A</sub> = +25°C                                   | C, E        | -0.2  | -0.01        | 0.2  | nA    |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -0.1  | -0.01        | 0.1  |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E        | -2.5  |              | 2.5  |       |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -5.0  |              | 5.0  |       |
| COM Off Leakage Current<br>(Note 8)              | I <sub>COM(OFF)</sub>                                      | V <sub>COM</sub> = 4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = 0V,<br>V+ = 5.5V, V- = 0V                                                            | T <sub>A</sub> = +25°C                                   | C, E        | -0.2  | -0.01        | 0.2  | nA    |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -0.1  | -0.01        | 0.1  |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E        | -2.5  |              | 2.5  |       |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -5.0  |              | 5.0  |       |
| COM On Leakage Current<br>(Note 8)               | I <sub>COM(ON)</sub>                                       | V <sub>COM</sub> = 4.5V,<br>V <sub>NC</sub> or V <sub>NO</sub> = 4.5V,<br>V+ = 5.5V, V- = 0V                                                          | T <sub>A</sub> = +25°C                                   | C, E        | -0.4  | -0.04        | 0.4  | nA    |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -0.2  | -0.04        | 0.2  |       |
|                                                  |                                                            |                                                                                                                                                       | T <sub>A</sub> = T <sub>MIN</sub><br>to T <sub>MAX</sub> | C, E        | -5.0  |              | 5.0  |       |
|                                                  |                                                            |                                                                                                                                                       |                                                          | M           | -20.0 |              | 20.0 |       |
| DIGITAL LOGIC INPUT                              |                                                            |                                                                                                                                                       |                                                          |             |       |              |      |       |
| Input Current with Input<br>Voltage High         | I <sub>INH</sub>                                           | V <sub>IN</sub> = 2.4V, all others = 0.8V                                                                                                             |                                                          |             | -1.0  | 0.005        | 1.0  | μA    |
| Input Current with Input<br>Voltage Low          | I <sub>INL</sub>                                           | V <sub>IN</sub> = 0.8V, all others = 2.4V                                                                                                             |                                                          |             | -1.0  | 0.005        | 1.0  | μA    |

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +5V ±10%, V- = 0V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                             | SYMBOL | CONDITIONS                                                 | MIN               | TYP<br>(Note 2) | MAX | UNITS |
|---------------------------------------|--------|------------------------------------------------------------|-------------------|-----------------|-----|-------|
| <b>DYNAMIC</b>                        |        |                                                            |                   |                 |     |       |
| Turn-On Time                          | tON    | VCOM = 3V, Figure 2                                        | TA = +25°C        | 160             | 250 | ns    |
|                                       |        |                                                            | TA = TMIN to TMAX |                 | 300 |       |
| Turn-Off Time                         | tOFF   | VCOM = 3V, Figure 2                                        | TA = +25°C        | 60              | 125 | ns    |
|                                       |        |                                                            | TA = TMIN to TMAX |                 | 175 |       |
| Break-Before-Make Time Delay (Note 3) | tD     | MAX383 only                                                | TA = +25°C        | 10              | 20  | ns    |
| Charge Injection (Note 3)             | VCTE   | CL = 1.0nF, VGEN = 0V, RGEN = 0Ω                           | TA = +25°C        | 2               | 5   | pC    |
| <b>SUPPLY</b>                         |        |                                                            |                   |                 |     |       |
| Power-Supply Range                    | V+     |                                                            | 2.7               |                 | 16  | V     |
| Positive Supply Current               | I+     | All channels on or off, VIN = 0V or V+, V+ = 5.5V, V- = 0V | -1.0              | 0.01            | 1.0 | μA    |
| Negative Supply Current               | I-     | All channels on or off, VIN = 0V or V+, V+ = 5.5V, V- = 0V | -1.0              | -0.01           | 1.0 | μA    |

## ELECTRICAL CHARACTERISTICS—Single +3.3V Supply

(V+ = 3.0V to 3.6V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER                             | SYMBOL               | CONDITIONS                                                                  | TEMP.<br>RANGE    | MIN  | TYP<br>(Note 2) | MAX   | UNITS |
|---------------------------------------|----------------------|-----------------------------------------------------------------------------|-------------------|------|-----------------|-------|-------|
| <b>SWITCH</b>                         |                      |                                                                             |                   |      |                 |       |       |
| Analog Signal Range                   | VCOM, VNO, VNC       | (Note 3)                                                                    |                   | 0V   |                 | V+    | V     |
| On-Resistance                         | RON                  | V+ = 3V, V- = 0V, VNC or VNO = 1.5V, ICOM = 1.0mA, VINH = 2.4V, VINL = 0.8V | TA = +25°C        | C, E | 75              | 185   | Ω     |
|                                       |                      |                                                                             |                   | M    |                 | 175   |       |
| NC or NO Off Leakage Current (Note 8) | INC(OFF) or INO(OFF) | VCOM = 0V, VNC or VNO = 3V, V+ = 3.6V, V- = 0V                              | TA = +25°C        | C, E | -0.2            | -0.01 | nA    |
|                                       |                      |                                                                             |                   | M    | -0.1            | -0.01 |       |
|                                       |                      |                                                                             | TA = TMIN to TMAX | C, E | -2.5            |       |       |
|                                       |                      |                                                                             |                   | M    | -5.0            | 5.0   |       |
| COM Off Leakage Current (Note 8)      | ICOM(OFF)            | VCOM = 3V, VNC or VNO = 0V, V+ = 3.6V, V- = 0V                              | TA = +25°C        | C, E | -0.2            | -0.01 | nA    |
|                                       |                      |                                                                             |                   | M    | -0.1            | -0.01 |       |
|                                       |                      |                                                                             | TA = TMIN to TMAX | C, E | -2.5            |       |       |
|                                       |                      |                                                                             |                   | M    | -5.0            | 5.0   |       |
| COM On Leakage Current (Note 8)       | ICOM(ON)             | VCOM = 3V, VNC or VNO = 3V, V+ = 3.6V, V- = 0V                              | TA = +25°C        | C, E | -0.4            | -0.04 | nA    |
|                                       |                      |                                                                             |                   | M    | -0.2            | -0.04 |       |
|                                       |                      |                                                                             | TA = TMIN to TMAX | C, E | -5.0            |       |       |
|                                       |                      |                                                                             |                   | M    | -20.0           | 20.0  |       |

# Precision, Low-Voltage Analog Switches

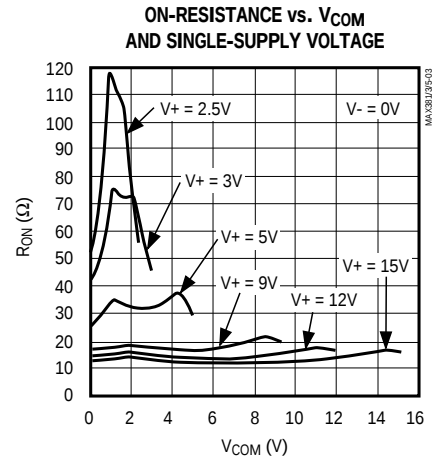
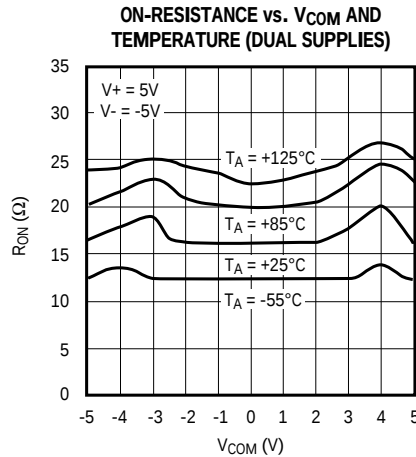
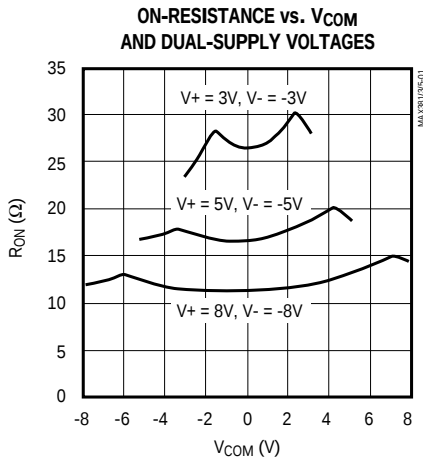
## ELECTRICAL CHARACTERISTICS—Single +3.3V Supply (continued)

( $V_+ = 3.0\text{V}$  to  $3.6\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{\text{INH}} = 2.4\text{V}$ ,  $V_{\text{INL}} = 0.8\text{V}$ ,  $T_A = T_{\text{MIN}}$  to  $T_{\text{MAX}}$ , unless otherwise noted.)

| PARAMETER                             | SYMBOL           | CONDITIONS                                                                                                                | MIN  | TYP<br>(Note 2) | MAX | UNITS         |
|---------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------|------|-----------------|-----|---------------|
| <b>DIGITAL LOGIC INPUT</b>            |                  |                                                                                                                           |      |                 |     |               |
| Input Current with Input Voltage High | $I_{\text{INH}}$ | $V_{\text{IN}} = 2.4\text{V}$ , all others = $0.8\text{V}$                                                                | -1.0 | 0.005           | 1.0 | $\mu\text{A}$ |
| Input Current with Input Voltage Low  | $I_{\text{INL}}$ | $V_{\text{IN}} = 0.8\text{V}$ , all others = $2.4\text{V}$                                                                | -1.0 | 0.005           | 1.0 | $\mu\text{A}$ |
| <b>DYNAMIC</b>                        |                  |                                                                                                                           |      |                 |     |               |
| Turn-On Time (Note 3)                 | $t_{\text{ON}}$  | $V_{\text{COM}} = 1.5\text{V}$ , Figure 2<br>$T_A = +25^\circ\text{C}$                                                    |      |                 | 400 | ns            |
| Turn-Off Time (Note 3)                | $t_{\text{OFF}}$ | $V_{\text{COM}} = 1.5\text{V}$ , Figure 2<br>$T_A = +25^\circ\text{C}$                                                    |      |                 | 150 | ns            |
| Break-Before-Make Time Delay (Note 3) | $t_{\text{D}}$   | MAX383 only<br>$T_A = +25^\circ\text{C}$                                                                                  | 10   | 20              |     | ns            |
| Charge Injection (Note 3)             | $V_{\text{CTE}}$ | $C_{\text{L}} = 1.0\text{nF}$ ,<br>$V_{\text{GEN}} = 0\text{V}$ , $R_{\text{GEN}} = 0\Omega$<br>$T_A = +25^\circ\text{C}$ |      | 1               | 5   | pC            |
| <b>SUPPLY</b>                         |                  |                                                                                                                           |      |                 |     |               |
| Power-Supply Range                    | $V_+$            |                                                                                                                           | 2.7  |                 | 16  | V             |
| Positive Supply Current               | $I_+$            | All channels on or off, $V_{\text{IN}} = 0\text{V}$ or $V_+$ ,<br>$V_+ = 3.6\text{V}$ , $V_- = 0\text{V}$                 | -1.0 | 0.01            | 1.0 | $\mu\text{A}$ |
| Negative Supply Current               | $I_-$            | All channels on or off, $V_{\text{IN}} = 0\text{V}$ or $V_+$ ,<br>$V_+ = 3.6\text{V}$ , $V_- = 0\text{V}$                 | -1.0 | -0.01           | 1.0 | $\mu\text{A}$ |

## Typical Operating Characteristics

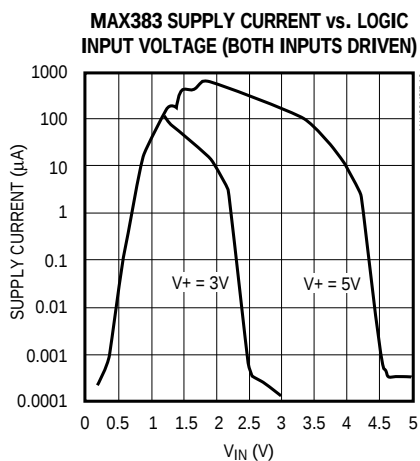
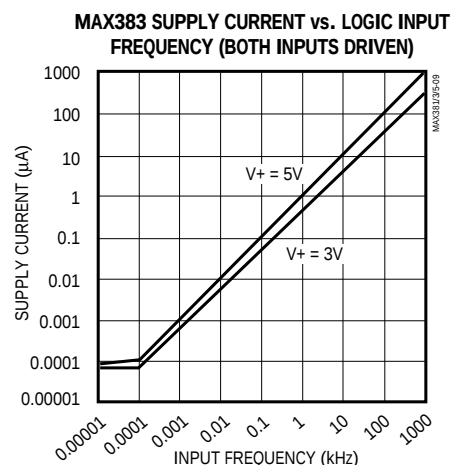
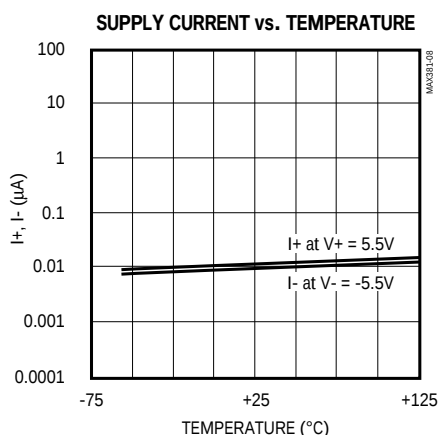
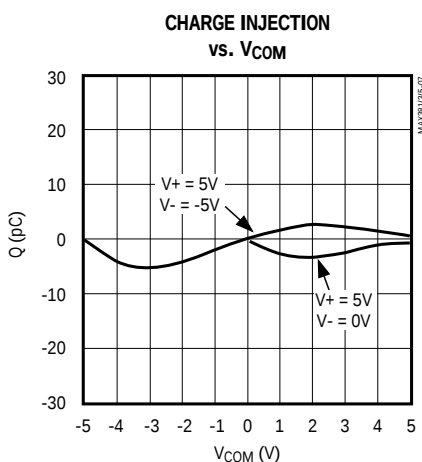
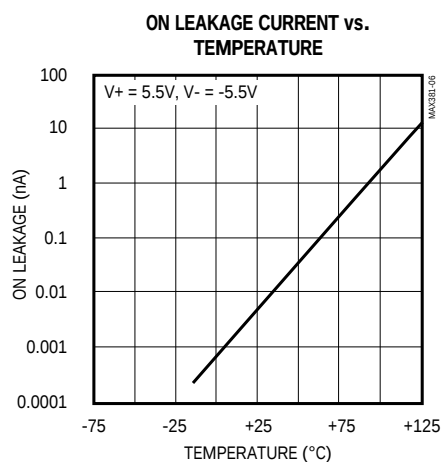
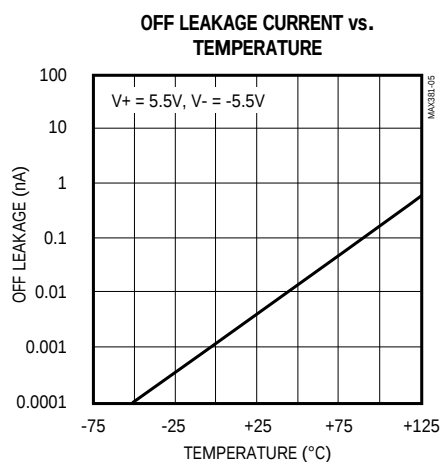
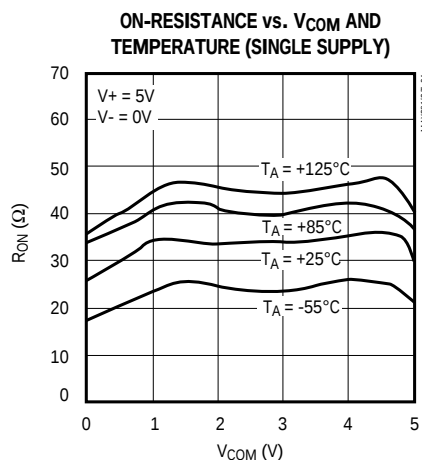
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# Precision, Low-Voltage Analog Switches

## Typical Operating Characteristics (continued)

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# Precision, Low-Voltage Analog Switches

## Pin Description

| PIN     |            |             | NAME | FUNCTION                                      |
|---------|------------|-------------|------|-----------------------------------------------|
| MAX381  | MAX383     | MAX385      |      |                                               |
| 1, 8    | 1, 3, 6, 8 | 1, 3, 6, 8  | COM_ | Analog Switch Common Terminal                 |
| 2–7, 12 | 2, 7, 12   | 2, 7, 12    | N.C. | Not Internally Connected                      |
| 9, 16   | 9, 16      | 4, 5, 9, 16 | NO_  | Analog Switch Normally Open Terminal          |
| —       | 4, 5       | —           | NC_  | Analog Switch Normally Closed Terminal        |
| 10, 15  | 10, 15     | 10, 15      | IN_* | Logic Level Input (Normally Low)              |
| 11      | 11         | 11          | V+   | Analog Signal and Logic Positive Supply Input |
| 13      | 13         | 13          | GND  | Logic Negative Supply Input (Ground)          |
| 14      | 14         | 14          | V-   | Analog Signal Negative Supply Input           |

\* IN1 controls COM1 and COM3; IN2 controls COM2 and COM4.

## Applications Information

### Operation with Supply Voltages Other than $\pm 5V$

The MAX381/MAX383/MAX385 switches operate with  $\pm 3.0V$  to  $\pm 8V$  bipolar supplies and a  $+3V$  to  $+15V$  single supply. In either case, analog signals ranging from  $V+$  to  $V-$  can be switched. The *Typical Operating Characteristics* graphs show the typical on-resistance variation with analog signal and supply voltage. The usual on-resistance temperature coefficient is  $0.5\%/^{\circ}C$  (typ).

### Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence  $V+$  on first, then  $V-$ , followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small signal diodes ( $D1$ ,  $D2$ ) in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below  $V+$  and one diode drop above  $V-$ , but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between  $V+$  and  $V-$  should not exceed  $17V$ . These protection diodes are not recommended when using a single  $3V$  supply.

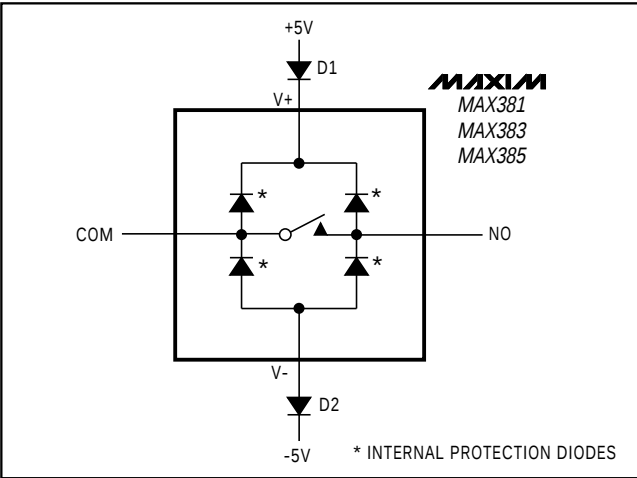


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

# Precision, Low-Voltage Analog Switches

## Test Circuits/Timing Diagrams

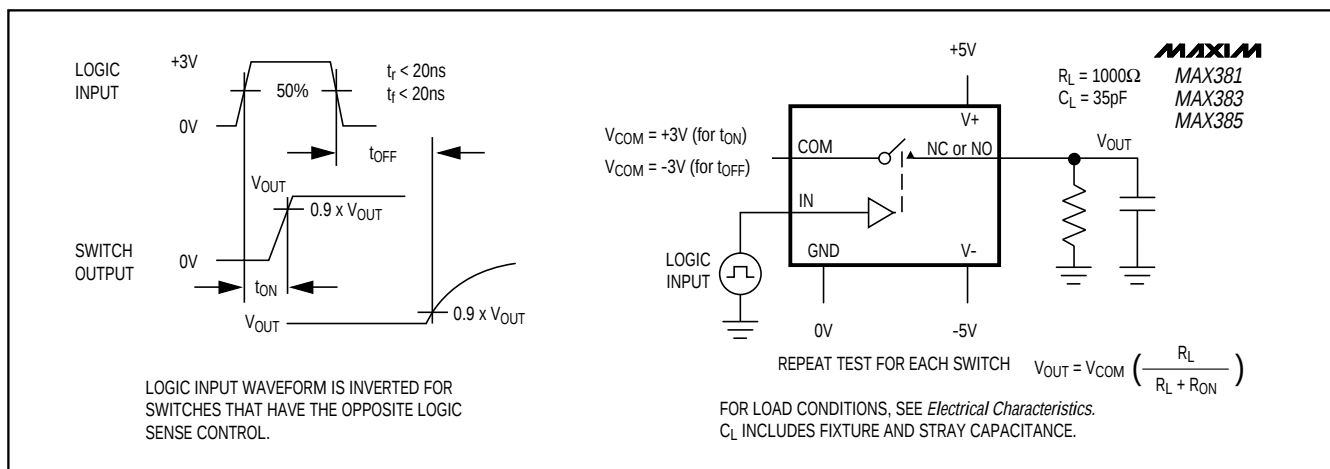


Figure 2. Switching-Time Test Circuit

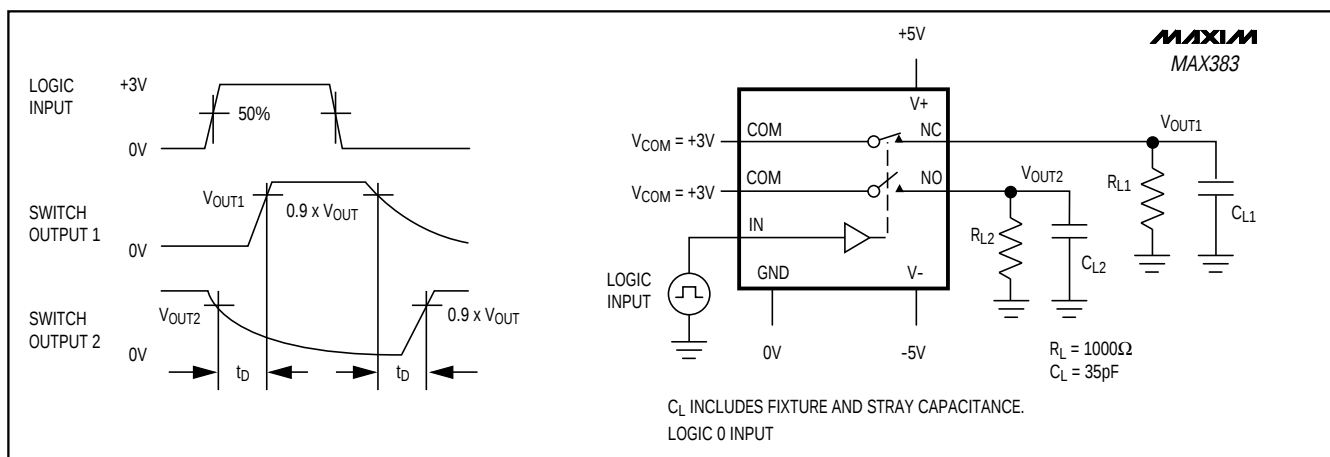


Figure 3. Break-Before-Make Test Circuit (MAX383 only)

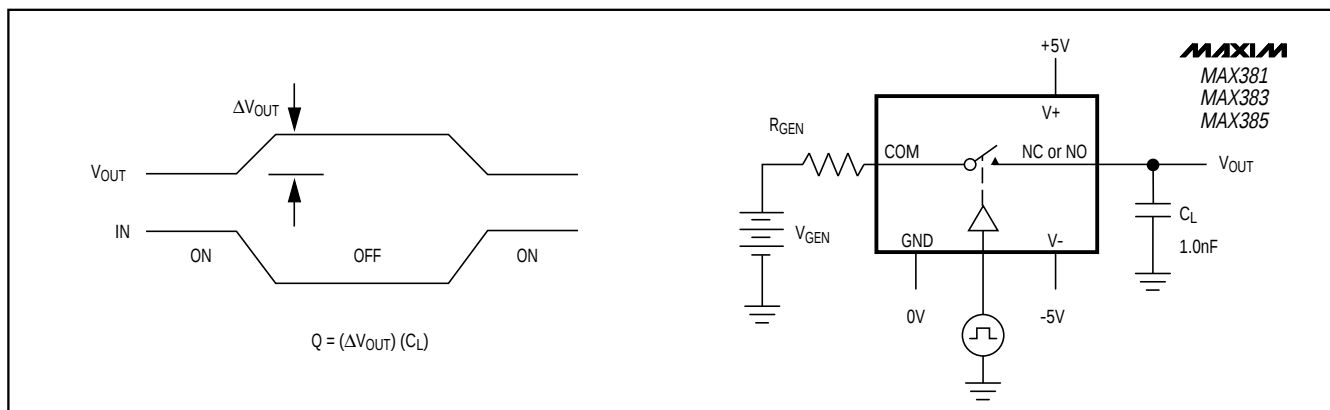


Figure 4. Charge-Injection Test Circuit

# Precision, Low-Voltage Analog Switches

## Test Circuits/Timing Diagrams (continued)

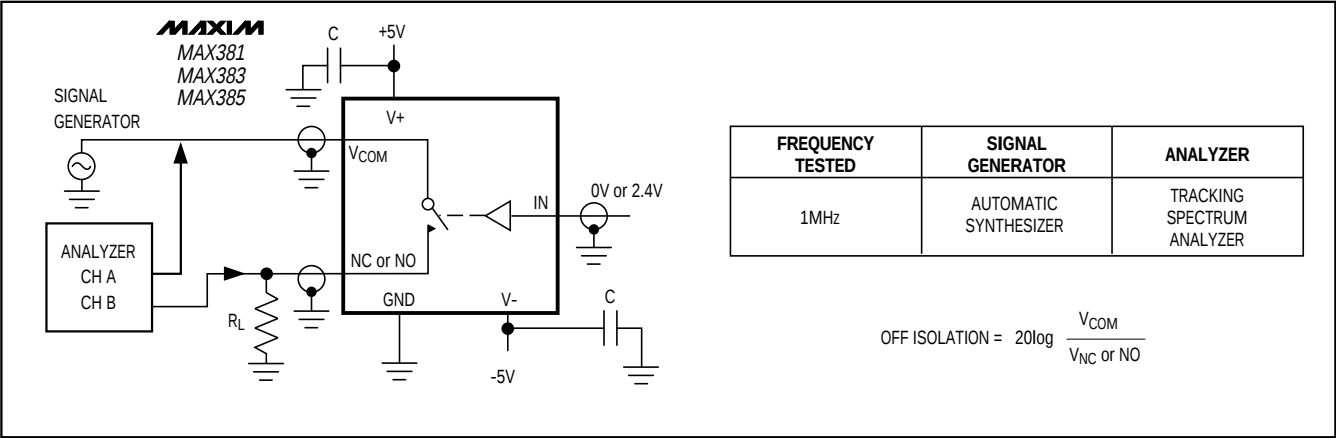


Figure 5. Off Isolation

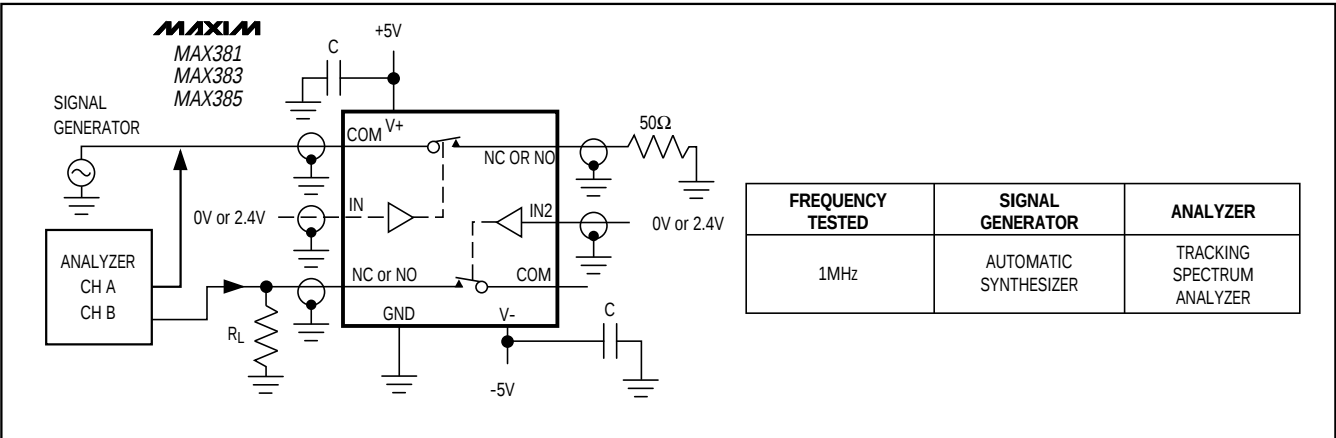


Figure 6. Crosstalk Test Circuit

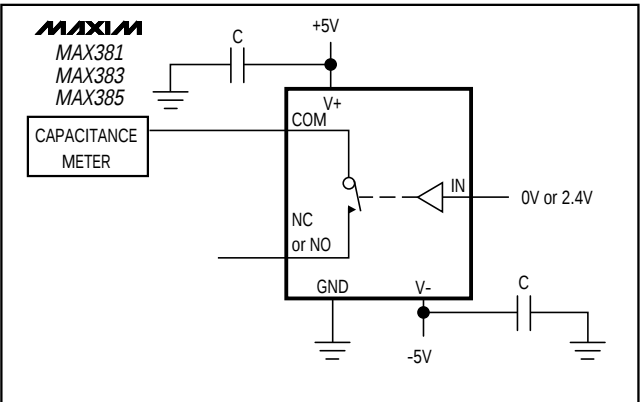


Figure 7. Channel-Off Capacitance

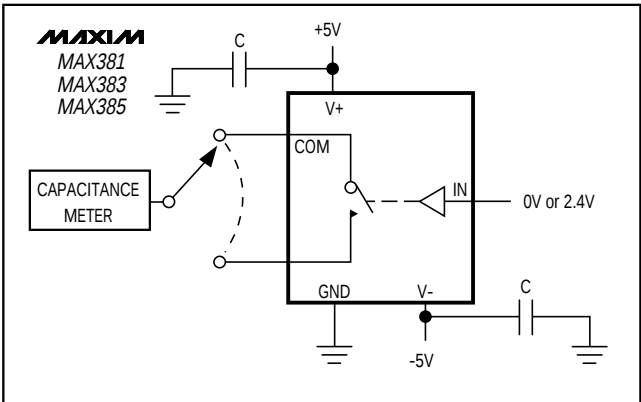


Figure 8. Channel-On Capacitance

# Precision, Low-Voltage Analog Switches

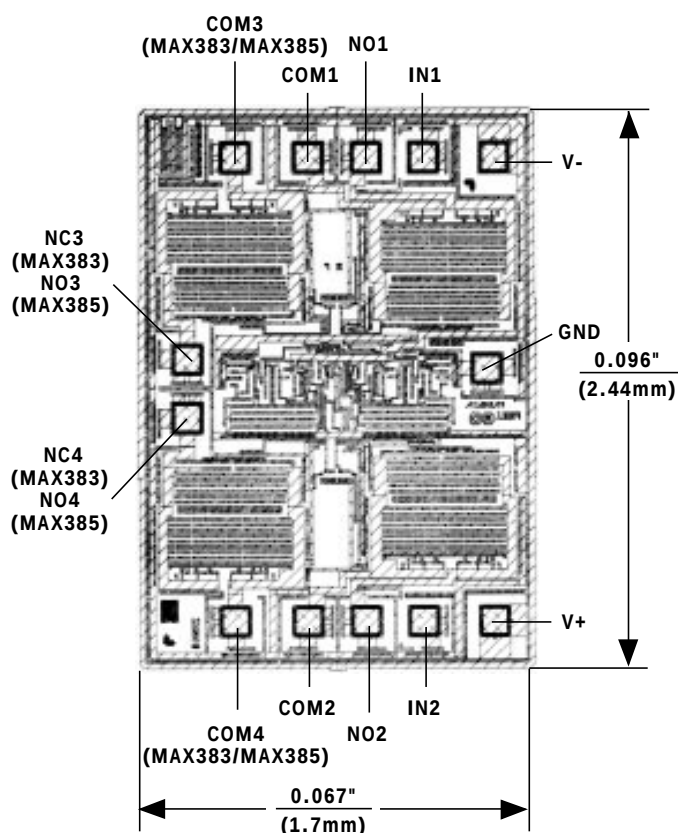
## Ordering Information (continued)

| PART      | TEMP. RANGE     | PIN-PACKAGE    |
|-----------|-----------------|----------------|
| MAX383CPE | 0°C to +70°C    | 16 Plastic DIP |
| MAX383CSE | 0°C to +70°C    | 16 Narrow SO   |
| MAX383C/D | 0°C to +70°C    | Dice*          |
| MAX383EPE | -40°C to +85°C  | 16 Plastic DIP |
| MAX383ESE | -40°C to +85°C  | 16 Narrow SO   |
| MAX383EJE | -40°C to +85°C  | 16 CERDIP**    |
| MAX383MJE | -55°C to +125°C | 16 CERDIP**    |
| MAX385CPE | 0°C to +70°C    | 16 Plastic DIP |
| MAX385CSE | 0°C to +70°C    | 16 Narrow SO   |
| MAX385C/D | 0°C to +70°C    | Dice*          |
| MAX385EPE | -40°C to +85°C  | 16 Plastic DIP |
| MAX385ESE | -40°C to +85°C  | 16 Narrow SO   |
| MAX385EJE | -40°C to +85°C  | 16 CERDIP**    |
| MAX385MJE | -55°C to +125°C | 16 CERDIP**    |

\* Dice are tested at  $T_A = +25^\circ\text{C}$  only.

\*\* Contact factory for package availability.

## Chip Topography

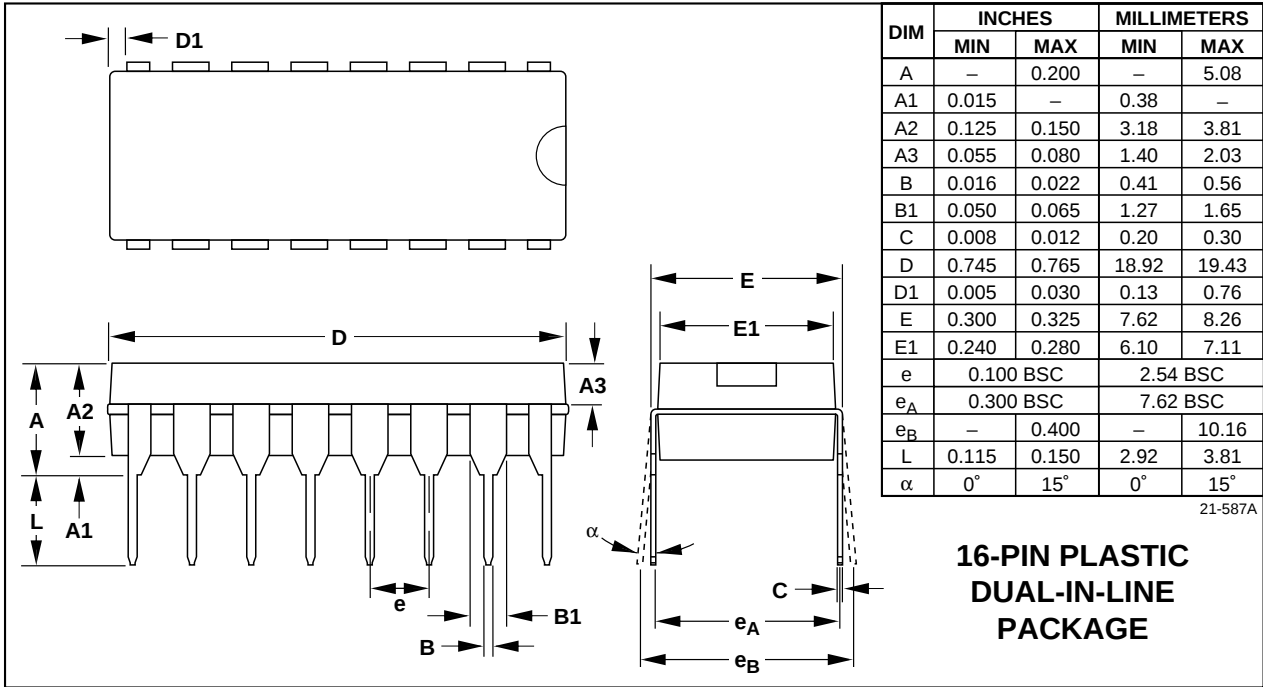
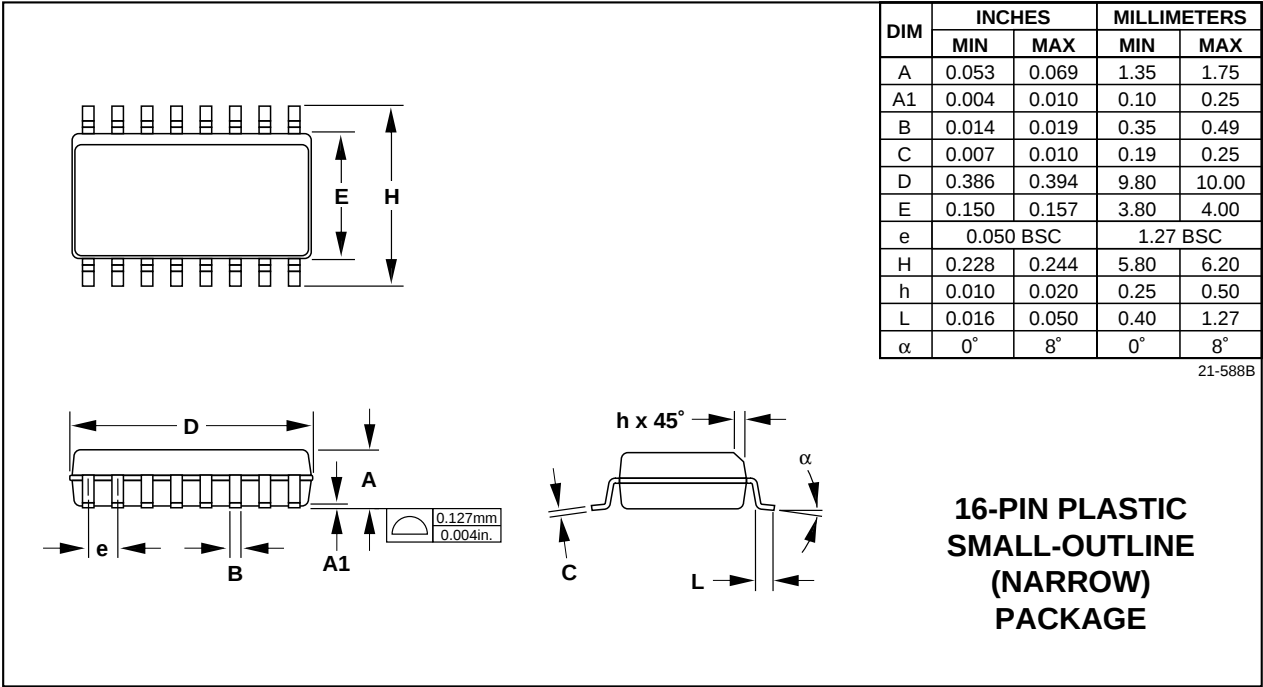


MAX381/MAX383/MAX385

TRANSISTOR COUNT: 57  
SUBSTRATE CONNECTED TO V+

# Precision, Low-Voltage Analog Switches

## Package Information



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.